

## A NEW SPECIES OF BUSHCRICKET (ORTHOPTERA: TETTIGONIIDAE) OF THE PALAEARCTIC GENUS *ISOPHYA* (PHANEROPTERINAE) FROM TURKEY<sup>1</sup>

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**ABSTRACT:** The new bushcricket species *Isophya rizeensis* is described from montane forest and subalpine zones of Mt. Kaçkar, Turkey. Its relation with other related members of the genus is discussed on the basis of morphological and bioacoustical traits. Data on the song and stridulatory organs of the new species are also presented.

**Key Words:** Orthoptera, Tettigoniidae, Phaneropterinae, *Isophya*, Turkey, calling song.

The genus *Isophya* Brunner von Wattenwyl (Orthoptera, Tettigoniidae) is, by far, one of the large genus of the subfamily Phaneropterinae, containing about 90 species (Otte et al., 2004). Like the closely related largest genus *Poecilimon* Fischer, *Isophya* species occur mainly in Southeastern Europe, Anatolia and Caucasia (e.g. Ramme, 1951; Bei-Bienko, 1954; Karabag, 1958; Harz, 1969; Heller et al., 1998), many of them having very restricted ranges within this area. Turkey was already known for a remarkably high number of *Isophya* species and the majority is endemic to Anatolia (Çyplak et al., 2002; Sevgili and Heller, 2003). All are short winged, usually green or blackish colored, living in forests (e.g. *I. redtenbacheri*), forest edges (e.g. *I. paveli*), shrubby (e.g. *I. hakkarica*) and maquis vegetation (e.g. *I. rodsjankoi*) or steppe vegetation (e.g. *I. nervosa*) from sea level to above the timberline.

The differential diagnosis of species within *Isophya* is based on small differences in some morphological structures, such as the pronotum, tegmina, male cerci, the female subgenital plate, ovipositor and some morphometric characters (e.g. Ramme, 1951; Bei-Bienko, 1954; Karabag, 1962; Sevgili and Heller, 2003). Therefore, the acoustic signals used for mate finding and attracting behavior of males and females can be very useful diagnostic characters as songs of closely related species may often differ in one or more parameters (e.g. Zhantiev and Korsunovskaya, 1986; Heller, 1988, 1990; Ragge and Reynolds, 1998; Stumpner and Meyer, 2001; Orci et al., 2001). Documentation of the acoustic and mating behaviors of the numerous *Isophya* species is still largely incomplete. Calling songs of *Isophya* species have mostly been recorded for European (Zhantiev and Dubrovin, 1977; Heller, 1988; Ingrisch, 1991; Orci et al., 2001) and Anatolian species (9 species) (Heller, 1988, 1990). In this paper, we describe a new species, *Isophya rizeensis*, known from Çamlıyehemsin (Rize Prov.) in the East Black Sea Region (Dogu Karadeniz Bölgesi) of Turkey. In addition, we present the description of the male calling song of the new species. This study is part of a larger project on the systematics and calling songs of the genus *Isophya* in Turkey.

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## METHODS

**Bush crickets.** All specimens were collected from the East Black Sea Region of Turkey. Some were preserved in alcohol, but living specimens were examined for coloration. The type material, including holotype, examined in this study are deposited in HUZOM (Hacettepe University, Zoology Museum, Ankara, Turkey). Morphological terminology follows Ramme (1951), Bei-Bienko (1954), Harz (1969) and Sevgili and Heller (2003). Figures were drawn and measurements were taken using a camera lucida attached to a stereo microscope. Measurements were defined as follows: total length, the distance between the frons and apex of abdomen (excluding ovipositor); length of pronotum (pronotal disc), the median length of the disc from anterior to posterior margin; length of tegmina, the distance between the rear margin of the pronotum to tegmen tip as viewed laterally; length of hind femur, the greatest dimension of this structure as seen in lateral view (excluding trochanter); length of ovipositor, the distance from the apex of the ovipositor to the apex of the subgenital plate. Measurements are given in mm. Stridulatory files were studied with a light microscope and a Scanning Electron Microscope (SEM). For electron microscopy, the left forewing was removed and transferred to absolute ethanol for at least 18 hours, cleaned using an ultrasonic cleaner, then air-dried and mounted on a microscope stub.

**Song nomenclature.** Calling song, song produced by an isolated male. Syllable, the sound produced by one complete up (opening) and down (closing) stroke of the wing. Impulse, a simple, undivided, transient train of sound waves. Syllable period (reciprocal value: syllable repetition rate), time period from the beginning of one syllable to the beginning of the next.

**Calling song.** The male calling songs were recorded in the laboratory using a Sony WM-GX688 Walkman and a stereo microphone (50 Hz to 18000 Hz) (distance to microphone about 10 cm). The calling songs of 12 males were recorded at temperatures between 23°C and 29°C. The males and females were kept acoustically isolated from the male being recorded. After digitising the songs on a PC, oscillograms (after filtering) and its analysis were made using a PC and the programs Spectra Plus, Turbolab and CoolEdit.

## SYSTEMATICS

Tettigonioidea: Tettigoniidae: Phaneropterinae: Barbitistini

*Isophya* Brunner von Wattenwyl, 1878

### *Isophya rizeensis*, NEW SPECIES

(Figs. 1-6, 8-20, 22)

**Type locality.** TR. Rize Prov.- Çamlıyehmsin, Meydan köyü alty, 40°54' N 40°56' E, 900 m, 23 July 2002 (Leg. H. Sevgili).

**Description.** Male (holotype): Fastigium of vertex (Fig. 1) produced anteriorly, lateral margins parallel or slightly converging anteriorly, narrow, about 1/3x antennal scape, with dorsal groove.

Disc of pronotum (Fig. 2) constricted in middle of length, metazona slightly wider than prozona and with raised margins in prozona and metazona; anterior and posterior margins almost straight; in

profile (Fig. 3), dorsal surface of pronotum distinctly concave, ventral edge of paranota slightly convex and passing acutely into hind margin of pronotum. Tegmina (Figs. 2-3) 1.2x as long as pronotum; maximum width of disc of left tegmen almost as wide as hind margin of pronotum;  $Cu_2$   $\frac{3}{4}$ x as long as hind margin of pronotum, not thicker than 3rd antennal segment; tegmina with dense rugose venation; mirror almost quadrangular; costal area large with venation. Stridulatory file (Figs. 14-17) with 77-95 teeth ( $n=6$ ) not quite reaching posterior margin of tegmen, spacing largest in mid part of file; in ventral view slightly fusiform and arcuate, distal and proximal part of file gradually narrowed; length of file taken as shortest distance between proximal and distal most tooth about 2.85 mm. Hind femur about 4.25x longer than pronotum, without ventral spines.

Epiproct (Fig. 4) transverse, almost twice as wide as long, slightly concave at hind margin. Cercus (Figs. 4-6a, b) long, very distinctly incurved in apical part; incurved part long, forming about right angle with longitudinal axis of cercus, slightly tapering towards apex; apex pointed, ending in a distinct and black denticle on apex located somewhat dorsally. Subgenital plate (Figs. 4, 8) large and relatively long, extending beyond middle of cerci while cerci in normal position; slightly narrowed apically with distinct trapezoidal or rounded notch.

**Coloration:** Highly variable in colouration as in *I. redtenbacheri* (Bei-Bienko, 1954). Males belong to two basic colour morphs; almost black specimens were collected in lowlands (600-1000 m altitudes), light brown or yellowish-green specimens in subalpine zones of Kaçkar mountains (Kaçkar Daçy). In both morphs, main colour of tegmina of male blackish or claret red in subcoastal and radial areas including veins. Abdomen usually two light longitudinal bands dorsally; ventral surface of abdomen yellow or red in some specimens. Apex of cercus usually black.

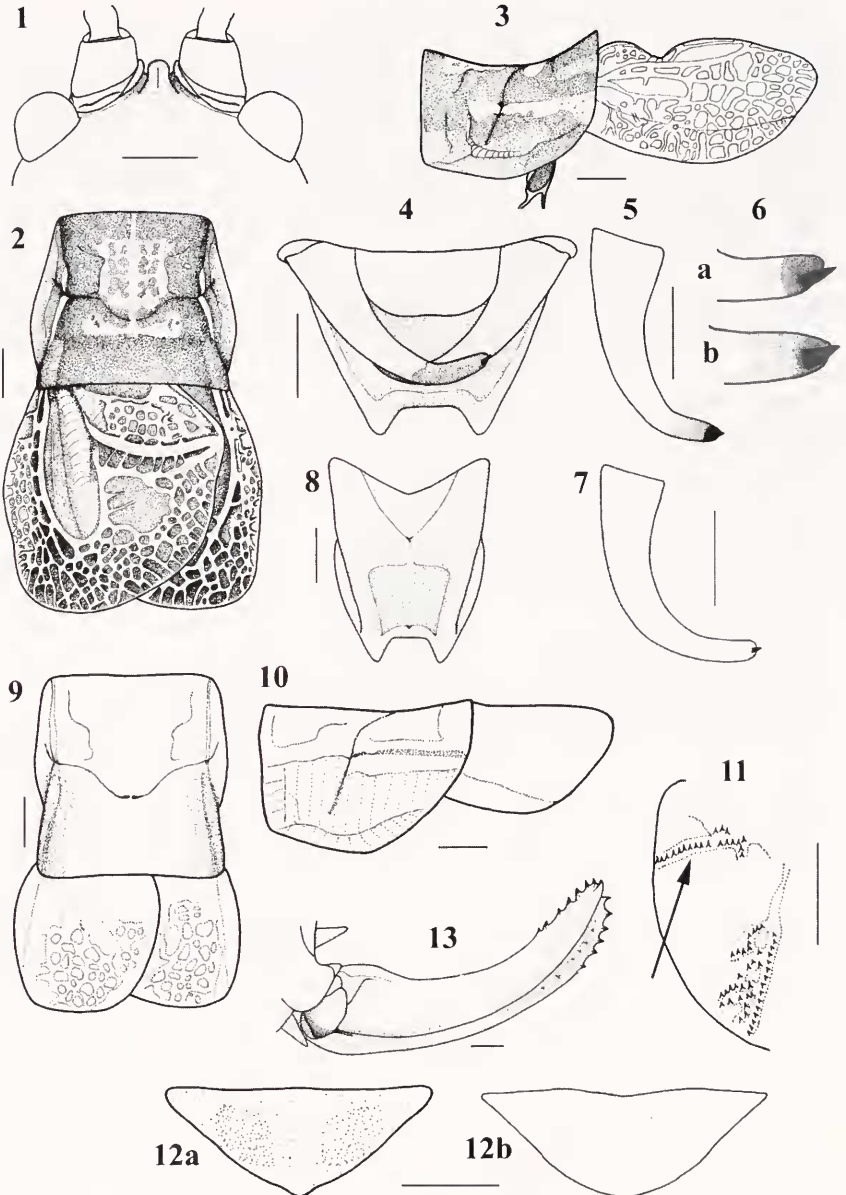
**Female:** Fastigium of vertex as in male, but slightly robust at apex. Disc of pronotum (Fig. 9) cylindrical, slightly constricted in mesozona, prozona and metazona of equal width; in profile (Fig. 10), dorsal surface of pronotum slightly concave, metazona slightly raised; ventral edge of paranota convex. Tegmina (Figs. 9-10) about 0.7x as long as pronotum, with dense rugose venation; stridulatory area of right tegmen as Fig. 11.

Cercus short and conical, slightly longer than epiproct. Subgenital plate (Fig. 12a, b) wider than long, posteriorly rounded or usually with a short median process at hind margin. Ovipositor (Fig. 13) long and distinctly upcurved, about 2.2x as long as pronotum; upper margin with 6-8, lower margin with 7-10 denticles at apical part. Gonangulum slightly swollen antero-dorsally, hind margin slightly convex; dorsal part narrower than ventral part; lamella folded with gonangulum forming deep groove. Coloration similar to male, but green specimens are dominant.

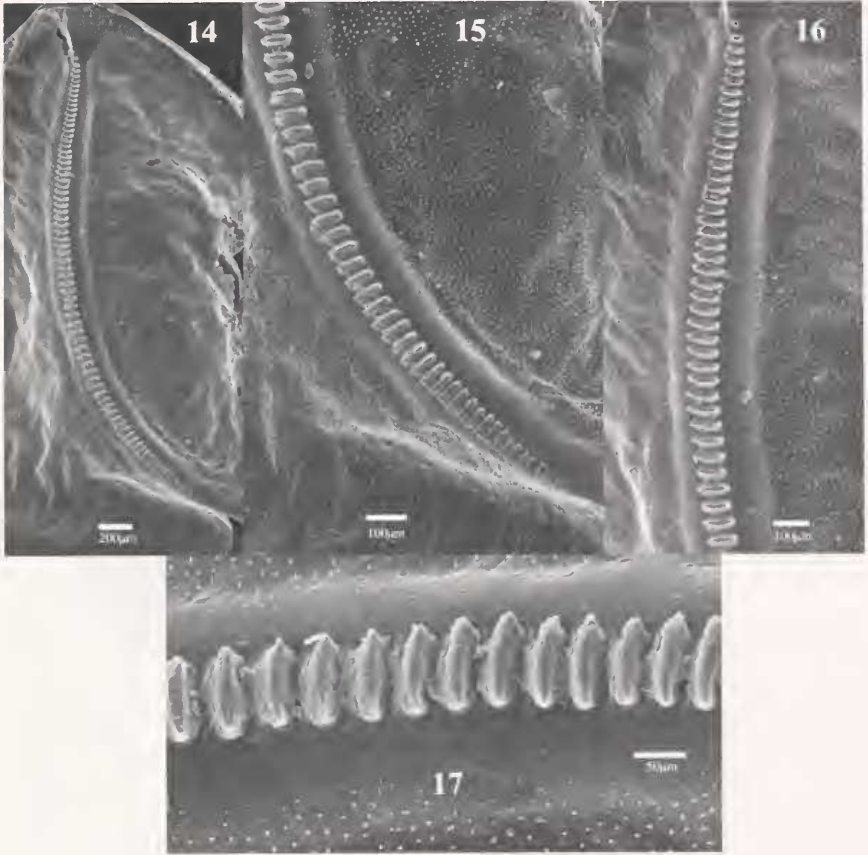
**Song:** (12 males recorded) The male calling song produced throughout the day but mainly at night. The song consists of two syllables (Figs. 18-20), recorded at 23-29°C. This calling song can be heard mainly in July and August, audible at a distance of 8-10 m. The song can be formulated as (A.....B) or sometimes (A.....B+tick or isolated impulse), repeated at very variable intervals (mostly 6-10 s,  $n=18$ ). "After-tick" are also usually present. The average duration of the song ranges between  $453 \pm 12$  ms (at 24°C) and  $395 \pm 7$  ms (at 28-29°C). The average gaps between two syllables is about  $261 \pm 12$  ms (at 24°C) and  $199 \pm 4$  ms (at 29°C). The average number of impulses of (A) first decrescendo type syllable ranges from 29 to 31. The second syllable (B) is crescendo type and consists of 45-56 impulses. The first syllable period (A.....) lasts about  $334 \pm 10$  ms (at 24°C) and  $277 \pm 3$  (at 28-29°C). The duration of this syllable (A) is approximately 73 ms. The mean duration of second syllable (B) longer than first, evaluated range from  $118 \pm 7$  ms (at 24°C) and  $120 \pm 6$  ms (at 28-29°C).

**Measurements** (male,  $n=40$ ; female,  $n=25$ ; (mean  $\pm$  SD)): Length of body: male 17.7-25 (21.6  $\pm$  0.25), female 19-23.8 (21.7  $\pm$  0.3); pronotum: male 3.1-4.2 (3.7  $\pm$  0.04), female 3.8-4.8 (4.4  $\pm$  0.05); tegmina: male 3.9-5 (4.6  $\pm$  0.03), female 2.4-3.5 (2.9  $\pm$  0.1); hind femur: male 14.4-17 (15.9  $\pm$  0.1), female 16-19.2 (17.5  $\pm$  0.2); ovipositor: 9-12 (10.5  $\pm$  0.1).

**Material examined (52 males, including holotype, 25 females):** Turkey: Holotype-male: TR. Rize- Çamlyhemsin, Meydan köyü alty 40°54' N 40°56' E, 900 m, 23 July 2002 (Leg. H. Sevgili). Paratypes: same locality, 1 male; - Çamlyhemsin, Palovit deresi ayrymy, 40°56' N 40°58' E, 600 m, July 23, 2002, 6 males, 2 females (4 males, 1 female in alcohol); - Çamlyhemsin, Zilkale köyü, Yüksek otuklarda, 40°54' N 40°56' E, 885 m, July 24, 2002, 2 males, 1 female (1 male in alcohol); - Çamlyhemsin, Elevit, Subalpin zon, 40°51' N 41°00' E, 1890 m, July 24, 2002, 8 males, 2 females (4 males in alcohol) (Leg. H. Sevgili); Rize- Meydan köyü, 1100 m, July 18, 1991, 10 males, 2 females;



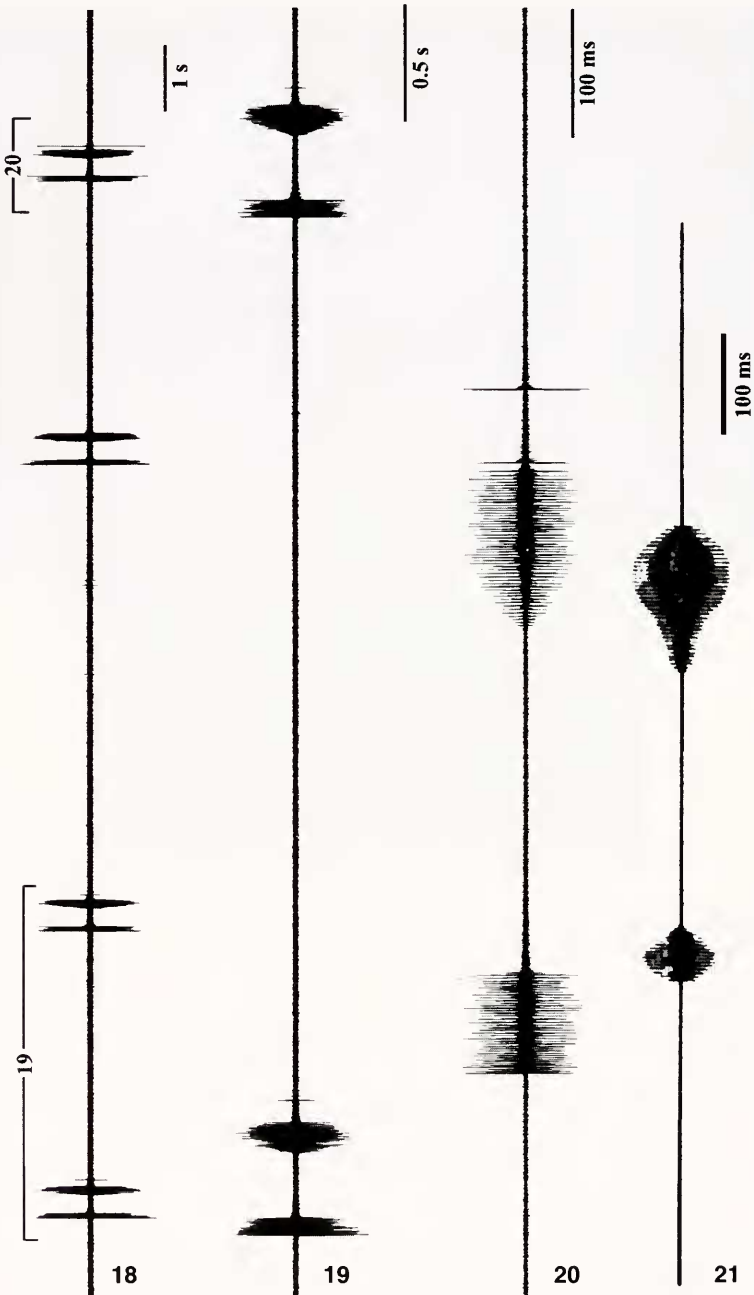
Figs. 1-13. Morphological features of *Isophya rizeensis* n. sp. (Figs. 1-6, 8-13) and *I. redtenbacheri* (Fig. 7); 1, male fastigium of vertex, dorsal view; 2, male pronotum and tegmina, dorsal view; 3, ditto, lateral view; 4, male epiproct, cerci and subgenital plate, dorsal view; 5, male left cercus; 6a, b, male apical parts of the cerci; 7, male left cercus of *I. redtenbacheri*; 8, male subgenital plate, ventral view; 9, female pronotum and tegmina, dorsal view; 10, ditto, lateral view; 11, female stridulatory area of right tegmen; 12a, b, female subgenital plates; 13, ovipositor. Scales 1 mm.



Figs. 14-17. *Isophya rizeensis* n. sp. Electron micrographs of male left tegmina. 14, stridulatory file, ventral view, distal end to the left; 15, idem, proximal part of file; 16, idem, distal part of file; 17, idem, mid part of file.

Rize- Çat düzü, July 13, 1991, 1 female;- Çamlyhemsin, Çat-Elevit yolu, July 9, 1990, 1 male;- Çamlyhemsin, Çat köyü, Elevit deresi, July 16, 1991, 1 male;- Çamlyhemsin, July 20, 1989, 1 female;- Çamlyhemsin, Çat, July 20, 1989, 3 males, 4 females;- Çamlyhemsin, Vankşi yaylası, 2150 m, July 11, 1991, 4 males, 2 females;- Çamlyhemsin, Elevit yaylası, 2400 m, July 17, 1991, 1 male (Leg. A. Demirsoy);- Çamlyhemsin, Çat-Elevit yolu, July 9, 1990, 4 males, 1 female;- Çamlyhemsin, Çat düzü, July 9, 1989, 2 females (Leg. S. S. Çağlar);- Çamlyhemsin, Çat düzü, July 9, 1990, 5 males, 2 females;- Çamlyhemsin, Çat köyü, Vankşi yaylası, July 9, 1990, 4 males, 2 females (Leg. S. S. Çağlar and A. Demirsoy);- Kale- Hemsin yolu, July 10, 1991, 1 male, 1 female (Leg. A. Demirsoy) (HUZOM).

**Discussion:** This new species is well characterised in the male by the stridulatory file and abdominal terminalia and in the female by the ovipositor. These characters distinguish it clearly from all other described species of the genus *Isophya*. *I. rizeensis*, *I. redtenbacheri* and *I. gracilis* are closely related species of the *amplipennis* Group (*I. amplipennis*, *I. redtenbacheri*, *I. rizeensis* sp. n., *I.*



Figs. 18-21. Oscillograms at different speeds of the male calling songs of *Isophya rizeesis* n. sp. (Figs. 18-20, at 24°C) and *I. gracilis* (Fig. 21). 18, four calling songs; 19, two calling songs at higher resolution; 20, one calling song at higher resolution; 21, one calling song of *I. gracilis* (reprinted from Zhantiev and Dubrovin, 1977, with the kind permission of R. Zhantiev).

*speciosa*, *I. rodsjankoi*, *I. savignyi*, *I. splendida*, *I. uludaghensis*, *I. reticulata*, *I. sureyai*, *I. gracilis*, *I. pylnovi*, *I. kalishevskii*, *I. caspica*, *I. hemiptera*) exhibiting similarities in the structure of the narrow fastigium, the concave pronotum and tegmina having a dense rugose venation. *I. rizeensis* differs from *I. redtenbacheri* in the larger body in both sexes, the shorter incurvate part of cerci of male (Figs. 4-5, 7) and distinctly longer ovipositor (in *I. redtenbacheri*, 7-8.5 mm according to Bei-Bienko, 1954). It also differs from *I. gracilis*, by the thinner and longer cerci, bigger apical denticle of cerci in male and distinctly longer ovipositor (in *I. gracilis*, 7-7.5 mm according to Bei-Bienko, 1954). On the other hand, the structure of the pronotum and tegmina of the new species is rather similar to that of *I. amplipennis*, *I. reticulata* and *I. speciosa* in both sexes. *I. rizeensis* differs from these species by the stridulatory file of left tegmen, cerci and subgenital plate in the male and gonangulum and lamella in the female. The stridulatory file of the new species (with 77-95 teeth) resembles that of *I. reticulata*, which shows 100-122 teeth ( $n=5$ ). In contrary to fusiform file of *I. rizeensis*, the files of *I. amplipennis* (with 80-90 teeth) and *I. speciosa* (with 150-180 teeth) become gradually widened towards the distal part (see Heller, 1988).

The calling song of *I. rizeensis* (Figs. 18-20) resembles that of *I. rodsjankoi* (unpublished data) and *I. gracilis* (Fig. 21, see Zhantiev and Dubrovin, 1977), but some of the song parameters of *I. gracilis* differ from that of *I. rizeensis*. The duration of first syllable in *I. rizeensis* is longer than that in *I. gracilis*. *I. rizeensis* and *I. gracilis*, on the other hand, are basically similar to the durations of second syllable, the gap between two syllables and syllable period, but the amplitude modulation of the song is clearly different (for details see Zhantiev and Dubrovin, 1977). The new species is clearly defined by its song, differing in several characters from *I. rodsjankoi*. The duration of the calling song of *I. rizeensis* is shorter than that in *I. rodsjankoi*. Besides, the number of impulses of second syllable in *I. rizeensis* appears to be higher than in *I. rodsjankoi*. On the other hand, while the song of *I. rizeensis* consists of two syllables, *I. redtenbacheri*'s song consists of only one crescendo type syllable (unpublished data).

**Distribution and habitats:** The range of this species covers a small area of the East Black Sea Region of Turkey (Fig. 22): from the northern slopes of Kaçkar mountains (between 600-2500 m altitudes) to the lowlands of Çamlıyehemsin town in Rize province, a region of abundant rainfall. The distribution area of this species is situated in the Colchic sector of Euxinian province of Euro-Siberian phytogeographical region. Its vegetation consists of the formations of mesophytic forests, alpine meadows and scrubs. According to our observations, this species occurs in forest communities including ferns, glades and shrubs in lowlands, subalpine scrubs and meadows in highlands. The new species occurred syntopically with some other bushcrickets, such as *Poecilimon schmidti*, *P. similis*, *Phonochorion* spp., *Pholidoptera griseoptera* in lowlands and *Psorodonotus specularis* and *Phonochorion* in subalpine and alpine zones. Its nymphs are mainly found in the beginning of June and adults are found in July and August.

*Etymology:* Rize Province has many high mountains in the East Black Sea Region of Turkey containing numerous endemic faunal and floral elements.

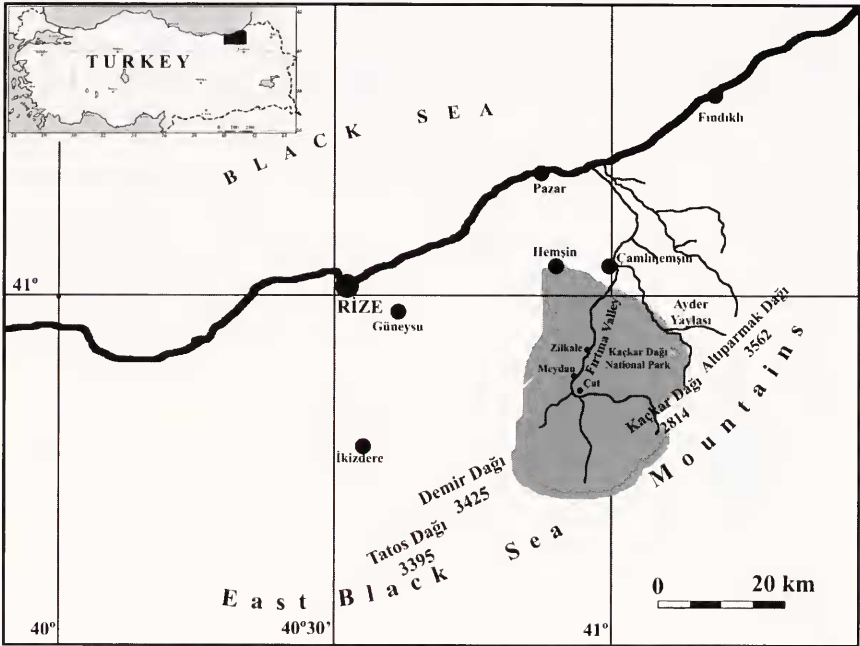


Fig. 22. Map of Rize Province, East Black Sea Region of Turkey. The stippled area indicates the distribution of *Isophya rizeensis* n. sp.

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